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(54) Chemical vapour deposition.

(57) Precursor (9) is atomised by being ionised (11,12) and is then vapourised (14) prior to deposition. The ionised vapour is controlled by electrodes (2,15) to control its flow and/or its deposition on a substrate.

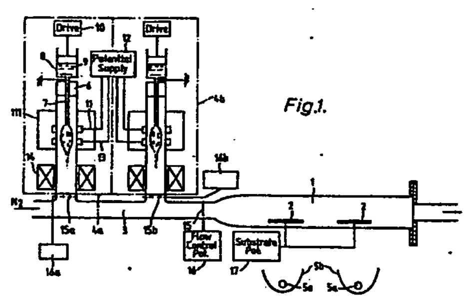

Fig.1.

EP 0 252 755 A1

D scripti n

CHEMICAL VAPOUR DEPOSITION

The present inv ntion relates to chemical vapour deposition (CVD). It is concerned for example with Metal-Organic Chemical Vapour Deposition (MOCVD) which is also known as Metal-Organic Vapour Phase Epitaxy (MOVPE). An illustrative application of the invention is the manufacture of integrated circuits.

Chemical Vapour Deposition is a known technique for depositing a layer of material onto a substrate. A precursor in liquid form, e.g. dissolved in a solvent, or in the form of a suspension or emulsion is vapourised, and the vapour flows to a chamber containing the substrate, where (some of) the vapour of precursor deposits on the substrate. The substrate is heated and the precursor decomposes to leave on the substrate a layer of the desired material. In MOCVD, the precursor is a metal organic compound of the desired material, which is advantageous because the chemical bonds of such a compound break easily at a relatively low temperature.

An inert carrier gas, e.g. Nitrogen, may be used to transport the vapour from its source to the substrate. The process may be carried out at atmospheric pressure (High Pressure MOCVD) or at less than atmospheric pressure (Low Pressure MOCVD).

Alternatively, the process may be carried out under conditions of near-vacuum.

It is known to produce vapourised precursor in the following way. The dissolved precursor is contained in a medical hypodermic syringe. The needle of the syringe extends through a sealed entrance port of the CVD apparatus. The syringe has a plunger which is driven by an electric stepper motor to introduce a succession of droplets into the apparatus. The droplets are heated in the apparatus to vapourise them. This known method of producing vapourised precursor has the disadvantage that the vapour is produced from a succession of relatively large drops, which are produced, and thus vapourised, at discrete intervals of time, resulting in fluctuations in concentration of the vapour at the substrate.

In accordance with one aspect of the present invention, fluctuations of concentration of vapour of precursor are reduced by continuously atomising and vapourising the precursor.

In accordance with another aspect of the present invention, liquid of precursor to be deposited on a substrate is either continuously atomised and ionised vapour produced from the atomised precursor or the liquid precursor is continuously atomised by being ionised and is then vapourised.

By continuously atomising the liquid precursor and vapourising the atomised precursor, concentration fluctuations are reduced because the atomisation process prevents droplets being formed even when a stepper motor is used.

In the known CVD method and apparatus it is difficult to control the vapour.

According to an embodiment of the said another aspect of the present invention, an electric field is used to control the ionised vapour of precursor.Alternatively a magnetic field is used to control the ionised vapour of precursor.

In the known CVD method a carrier gas is used which flows through the CVD apparatus resulting in a relatively high loss of the vapour which is swept out of the chamber. It is also difficult to control the flow of the vapour to the chamber and to control the deposition of the vapour on the substrate. Furthermore, when it is desired to introduce a different precursor into the apparatus it is necessary to wait until the previous precursor has been flushed out of the apparatus.

In another embodiment of the said another aspect of the invention, a flow control potential is applied to a flow control electrode in a path along which the vapour to be deposited flows. The flow control potential may be selected to substantially prevent the vapourised precursor from reaching the substrate. Thus, with the use of ionised precursor, it is possible using the flow control electrode to control the flow of ionised vapour. By applying a blocking potential to the electrode, flow of ionised vapour may be stopped quickly, without waiting for the vapour to be flushed out of the apparatus. The ionised vapour of another precursor can then be introduced into a chamber containing the substrate.

In yet another embodiment of said another aspect a substrate control potential is applied to the substrate onto which the vapour is to be deposited to control the deposition of the ionised vapour on the substrate.

Thus, with the use of ionised precursor it is possible to control the deposition of the ionised precursor onto the substrate electrically. By applying to the substrate a potential which attracts the ionised vapour to the substrate loss of precursor from the apparatus may be reduced.

For a better understanding of the present invention, reference will now be made by way of example to the accompanying drawings in which:

Figure 1 is a schematic diagram (which is not to scale) of an illustrative example of a CVD apparatus in accordance with the invention,

Figure 2 is a schematic diagram (which is not to scale) showing a modification of the apparatus of Figure 1,

Figure 3 is a schematic diagram (which is not to scale) of a further CVD apparatus in accordance with the invention,

Figure 4 is a schematic diagram (which is not to scale) of another CVD apparatus in accordance with the invention, and

Figures 5A and 5B are schematic diagrams of a CVD apparatus in accordance with the invention incorporating an ion selection arrangement.

The CVD apparatus shown in Figure 1 compris s a quartz chamber 1 containing a substrate 2 onto which a d sired material is to be deposited. An inert carrier gas such as Nitrogen or Argon flows from a

source (not shown) via a vapour flow path 3 into the chamber 1 and then out of the chamber. A source 4a having an exit vapour path connecting to the path 3 provides to the path 3 a vapour of precursor. The vapour of pr cursor is carried by the carrier gas to the chamber where it is deposited on the substrate 2. The substrate is heated by a heater 5, which in this example comprises an infra red heating element 5a in an elliptical reflector 5b. The precursor thermally decomposes on substrate to leave a layer of the desired material on the substrate 2.

In Figure 1, a further source 4b may be used to provide another precursor, also vapourised.

The apparatus may be operated at atmospheric pressure or at less than atmospheric pressure.

The precursor is a compound of the desired material, which decomposes to form the desired material. Examples of precursors and desired materials are known in the art: for example all Halides of the materials to be deposited.

The precursor may be a metal-organic compound of the desired material, such as is known in the art. For deposition of an oxide the precursor is an oxygen containing Metalorganic compound in particular a Metal Alkoxide. For deposition of a Metal the precursor is a Metal Alkyl. For a semiconductor many compounds are known in the art; e.g. for Gallium Arsenide the precursor is TMGa-AsH_3 or TE.Ga-AsH_3 where TM is trimethyl and TE is triethyl. In addition adducts of the form Trimethylindium-Trimethylamine adduct and Trimethylindium-Trimethylphosphine adduct may be used.

The substrate may be a semiconductor substrate as used in the manufacture of integrated circuits. For example it may be of silicon, germanium or a group III-V compound such as Gallium Arsenide.

The material deposited on the substrate may be a semiconductor, a metal, a metal oxide, e.g. Al_2O_3, TiO, a metal nitride, an oxide or nitride of silicon e.g. SiO, SiO or Si_3N_4. The material may also be a material such as Lead Titanate or Lithium Niobate which is an electro-acoustic material used in for example surface acoustic wave devices.

The source 4a (or 4b) comprises a sealed entry port 6 through which the needle of a medical hypodermic syringe extends. The syringe 8 contains the precursor in liquid form 9. For example the liquid precursor may be in the form of a suspension or emulsion. Alternatively the precursor may be dissolved in a solvent. As another alternative the liquid precursor may be in the form of a colloidal solution which allows insoluble materials to be used as precursors. The solvent is an organic material of very low water content and with high volatility as is known in the art, e.g. cyclohexane or benzene. A drive mechanism such as a stepper motor moves a plunger of the syringe to deliver the dissolved precursor. Alternatively gravity feed could be used.

In accordance with an aspect of the present invention, the precursor delivered from the syringe is continuously atomised and formed into an ionised vapour.

In the example shown in Figure 1, the needle 7 is earthed. An electrostatic induction electrode 11 which is held in a PTFE holder 111 surrounds the glass tube of the entry port 6, and the needle 7. The electrode 11 is energised by a potential supply 12 to minus 10kV or more to atomise the precursor by positively ionising it, as it is delivered from the needle. The atomised ionised precursor tends to move away from the needle and spread out due to the mutual repulsion of the like positive charges.

A further electrode 13 in the holder is energised to plus 10kV or more to compress the body of atomised ionised precursor.

The precursor is then heated by heaters 14 to vapourise it. The vapour may be heated to a temperature in the range 70°C to 300°C or even higher depending on the precursor and the liquid in which it is dissolved or suspended or with which it forms an emulsion or colloid. If the solvent is cyclohexane the temperature is about 150°C. The heaters are electrical resistance heaters in the examples shown in the Figures. Other suitable heaters may be used.

The vapourised and ionised precursor then flows through the vapour path at the exit of the source into the path 3. The ionised vapour is then carried by the carrier gas along the flow path 3 into the chamber 1.

A flow control electrode 15 is provided in the path 3. It may be for example a conductive mesh extending across the path. By suitably controlling the potential applied to the electrode by a source 16, the flow of the ionised vapour past the electrode 15 is controllable. By applying to the electrode a suitable voltage having the same polarity as the ions produced by the source 4a, e.g. plus 10kV or more in this example, the positive ions are repelled, stopping their flow to the chamber. Repulsion is preferred because the ions are not deposited on the electrode.

Alternatively by connecting the flow control electrode 15 to ground, or to a negative potential, the positively charged ions of the vapour supplied by source 4a are attracted to the electrode, also with the result that the flow is stopped. However, that has the possible disadvantage that ions which are deposited on the electrode may be released later when their presence in the chamber 1 is not desired.

Thus the flow of ions from the source 4a to the chamber 1 may be stopped, started, and controlled by the use of the flow control electrode.

The substrate 2 is supported on an electrode which may have a control potential applied to it from a source 17 to control the deposition of the ionised vapour on the substrate. For example by applying a negative potential to the electrode and thus the substrate, the positive ions from the source 4a are attracted to the substrate. That has the effect of reducing the amount of vapour of precursor which would otherwise be carried out of the chamber by the carrier gas. Also the amount of precursor which needs to be used may be reduced. Thus there will be less contamination of the interior surfaces of the chamber 1 by precursor.

By applying a suitable positive voltage to the substrate the positive ions may be repelled from th substrate.

As shown in Figure 1, there are two sources 4a, 4b of ionised vapourised precursor. As described

above, source 4a is used and it produces positive ions and flow control is performed only using the electrode 15 near the entrance of the chamber 1.

In a m dification of the apparatus of Figure 1 as so far described instead of providing one flow control electrode in the path 3, two electrodes 15a, 15b and potential sources 16a, 16b may be used in the respective vapour paths at the exits of the sources 4a, 4b to separately and independently control the flow of ions from the sources into the path. In addition the electrode 15 may be used as well to control the flow of vapour into the chamber 1.

In an alternative arrangement, shown in Figure 2 the sources 4a and 4b are coupled to the chamber 1 by separate flow paths 3a, 3b. Each path is provided with its own electrode 15a, 15b and potential supply 16a, 16b. Thus the flow of ionised vapour from the sources 4a, 4b is separately and independently controllable.

The sources 4a,4b could be operated to produce positive and negative ions respectively. The potential applied to the substrate may be controlled so as to repel the positive ions from source 4a and attract the negative ions from source 4b and vice/versa.

Referring to Figure 3 yet another CVD apparatus is shown. The apparatus has a source 4 of vapourised ions of precursor. The source includes a hypodermic syringe having a plunger driven by a suitable drive (not shown). Precursor delivered by an earthed needle 7 is atomised by being ionised. For that purpose an electrode 11 held in a PTFE holder 111 is energised to 10kV or more. The atomised and ionised precursor is vapourised by a heat source 14.

In the apparatus of Figure 3, a set of electrodes 30 are provided for forming a focussed beam 31 of ions which is directed onto, and may be scanned across, a substrate 2. The electrodes are individually energised by suitable energising means 32, via respective connections.

The set 30 of electrodes comprises electrodes 30a and 30b for focussing and accelerating the ions of precursor, and two pairs of electrodes 30c, 30d for scanning the focussed beam of ions across the substrate. The beam of ions is controlled to selectively deposit the precursor where required on the substrate 2 by scanning the beam path across the substrate and cutting off the beam as necessary.

In the apparatus of Figure 3, the set of electrodes 30 may be replaced by magnetic coils for magnetically forming the beam and scanning it across the substrate.

Figure 4, shows a further CVD apparatus in accordance with the invention. Various items of the apparatus of Figure 4 are the same as items of the apparatus of Figure 1 and are referenced with the same numerals in both figures. These items will not be further described.

The apparatus of Figure 4 has, in addition to the ionising electrode 11 which ionises and atomises the precursor 9, a further ioniser 40. The ioniser 40 is provided to ensure complete ionisation of the precursor. Complete ionisation is preferable and may not reliably occur with only one stage of ionisation. In the apparatus of Figure 4, the ioniser 40 comprises an RF, in this example a microwave, cavity to which RF or microwaves are supplied from a supply 41. The additional ioniser 40 is provided in the flow path 3.

Other forms of ioniser could be used: For example, a further induction electrode like electrode 11 could be us d, or a corona discharger could b used. Yet further, the already ioniser precursor could be passed through an election beam or passed through an arc discharge chamber to effect the further ionisation.

The further ioniser could be arranged within the source 4a or 4b.

The apparatus of Figure 4 is illustrated without flow control electrodes 15, 15a, 15b and potential source 16, 16a, 16b source of substrate potential control 17. Such electrodes and sources may be provided in the apparatus of Figure 4.

The apparatus of Figure 4 has an ultraviolet light source 42 together with a power supply 43 for irradiating the substrates 2. It also has temperature controllers 44 for controlling the heateres 44. A computer and control arrangement 45 controls the power supplies 12, 41, 43 controllers 44 heaters 5 pumps 45 and 46, and stepper motors 10.

Figure 5A shows yet another CVD apparatus in accordance with the invention. The apparatus comprises a first and second sources 4a and 4b of atomised, ionised vapourised precursor. Each source is as described above in which precursor 9 from a stepper motor driven syringe 8 is atomised by being ionised and is then vaporised and, if preferred, further ionised.

The ionised vapour from each source 4a, 4b is accelerated and focussed in an ion accelerating and focussing arrangement 52a, 52b. Such arrangements are known. One example is an Einzel lens arrangement. The focussed beam of ionised vapour is then supplied to an ion selector 50 which is, in effect, a mass spectrometer. The purpose of the ion selector 50 is to purify the ionised vapour before it is deposited on the substrate 2.

As is known in mass spectrometry, ionised vapour is passed through a magnetic field produced by magnets or electromagnets 51. The ionised vapour beam is bent through an angle dependent (amongst other parameters) on the mass of the ions. A barrier 53 with a small opening is placed between the substrate 2 and the magnets or electromagnets 51 to allow only ions of the correct mass to pass to the substrate 2. Impurities, which would have a different mass to the ions of the desired material would be deposited on the barrier. By providing two or more sources 4a, accelerators 52, selectors 50 and openings 54 in the barrier 53 two or more chemicals can be simultaneously deposited on the substrate. For example, one source 4a may include trimethyl Galllium and the other 4b may include Arsane AsH_3 , to form Gallium Arsenide on the substrat .

In one modification of the apparatus of Figur s 5A and 5B only on source 4, acclerator and focussor 52 and selector 50 are provided.

In another modification, and in accordance with a yet further aspect of the invention the or each source 4 is replaced by means for producing a beam of ions from a solid element or compound, e.g.

Gallium and/or Arsenic. The ion beam current can be controlled electronically very precisely. That is particularly useful when group III - V compounds are to be deposited, as it allows precise control of the amounts of each element which are deposited. In a further modification the magnets or electromagnets 51 are replaced by means for producing an el ctric field or by means for producing magnetic and electric fields.

Various modifications may be made to the above described embodiments. For example instead of directly atomising the precursor by ionising it alternatives may be used.

In one such alternative, the precursor delivered by the needle is ultrasonically atomised by for example a piezo-electric device attached to the needle.

The atomised precursor may then be ionised and then vapourised as described hereinbefore. In another alternative the atomised precursor is vapourised before being ionised.

The chamber 1 may be of stainless steel or Aluminium (or any other material known in the art to be suitable) instead of quartz.

The solvent in which the precursor is dissolved may be Methanol for those precursors for which it is suitable as known in the art.

The drive mechanism 10 may be a precision liquid dispenser which operates by producing controlled pulses of air pressure to displace liquid from a disposable syringe.

Instead of using an induction electrode 11 energised to a high voltage of opposite polarity to the ions to be produced and earthing the needle 7, the needle may be energised to a high potential with the same polarity as the ions to be produced to produce the ions by direct ionisation. That however is disadvantageous because the syringe and its contents are not at earth potential.

Although the invention has been described with the illustrative example of positive ions, negative ions may be used.

In order to deposit oxides, e.g. metal oxides on the substrate 2, the precursor 9 may be an oxygen containing Organo-metallic compound e.g. a metal alkoxide. Alternatively an organo-metallic precursor 9 may be used together with a separate source of Oxygen e.g. an ionised beam of oxygen or oxygen in gaseous form.

Various further modifications are possible within the scope of the invention. For example, instead of the arrangement shown in Figure 5b for purifying the vapour, the ionised vapour could be passed along a conduit which branches into two passageways one of which is for receiving the purified vapour and the other for receiving waste products, a field being provided in the region of the branch so as to direct the vapour and the waste products into the respective correct passageway utilising the difference in mass of these substances.

As will be understood from consideration of the foregoing description, the illustrated embodiments achieve atomisation electrostatically. This method of atomisation results in ionisation of the atmoised precursor and, after vapourisation, the ionised precursor can be controlled utilising electrical and/or magnetic fields. This combination of features is highly advantageous resulting in an inexpensive apparatus and method in which control, uniform deposition of precursor vapour on the substrate is efficiently achieved. The invention, however, also extends to modifications of this process and arrangement. For example, other means for atomising the liquid could be used instead of an electrostatic field, particularly where it is not desired to produce ionised vapour.

Claims

1. A method of chemical vapour deposition in which vapour comprising precursor is produced from a liquid and said vapour is deposited on a surface, wherein the production of said vapour includes the step of atomising said liquid.

2. A method according to claim 1, wherein ionised vapour is produced.

3. A method according to claim 2, which comprises atomising said liquid by applying a field which also ionises the atomised liquid.

4. A method according to claim 2 wherein atomised precursor is vapourised and the vapour is then ionised.

5. A method according to claim 2 wherein atomised precursor is ionised and the ionised, atomised precursor is then vapourised.

6. A method according to claim 2, comprising a further step of ionising the ionised precursor.

7. A method according to claim 6, wherein the further step is applied to the ionised, vapourised, precursor.

8. A method according to claim 2 wherein an electric field is used to control the ionised vapour of precursor.

9. A method according to claim 2 wherein a magnetic field is used to control the ionised vapour of precursor.

10. A method according to claim 8 wherein a deposition control potential is used to control the deposition of the ionised vapour on the substrate.

11. A method according to claim 10 wherein a deposition control potential is applied to the substrate, onto which the vapour is to be deposited, to control the deposition of the ionised vapour on the substrate.

12. A method according to claim 10 wherein the deposition control potential is selected to attract the vapour to the substrate.

13. A method according to claim 2 wherein a flow control electrode is placed in a path between a source of the ionised vapour and the substrate, and a flow control potential is appli d to the electrode to control the passage of the vapouris d precursor along the path.

14. A method according to claim 13 wherein the flow control potential is selected to substantially prevent the vapourised precursor from reaching the substrate.

15. A method according to claim 6 wherein the vapourised ionised precursor is formed into a beam which is focussed nto the target.

16. A method according to claim 15 wherein the focussed beam of precursor is directed to a predetermined portion of the substrate.

17. A method according to claim 2 further comprising selecting ionised precursor by mass spectrometry and directing the selected ionised precursor to the substrate.

18. A method according to claim 1 wherein the liquid precursor is in the form of a solution of precursor in a solvent, or of an emulsion, or of a suspension, or a colloid.

19. A method of chemical vapour deposition in which:

a plurality of sources of precursor produce respective ionised vapours of precursor by a process including continuously atomising liquid precursor;

a plurality of vapour paths couple the respective sources to a common chamber containing a substrate onto which the ionised vapours are to be deposited, and

in each vapour path ionised precursor to be deposited on the substrate is selected by mass spectrometry and the selected ionised precursor is directed to the substrate.

20. A method of chemical vapour deposition in which:

a plurality of sources of precursor produce respective ionised vapours of precursor by a process including continuously atomising liquid precursor;

a plurality of vapour paths couple the respective sources to a common chamber containing a substrate onto which the ionised vapours are to be deposited, and

flow control potentials are applied to the flow control electrodes in the respective vapour paths to control the flow of the ionised vapours from the sources to the chamber.

21. Apparatus for performing chemical vapour deposition, including means for atomising liquid precursor, means for vapourising the atomised precursor, and means for depositing the vapourised precursor on a surface.

22. Apparatus according to claim 21, including ionising means operable such that said vapour is ionised.

23. Apparatus according to claim 22 wherein said ionising means and said atomising means are constituted by an electrostatic atomising device which simultaneously atomises and ionises said liquid.

24. Apparatus according to claim 22 comprising further means for ionising the ionised precursor.

25. Apparatus according to claim 24 wherein the further ionising means is arranged to ionise th ionised vaporised precursor.

26. Apparatus according to claim 22 comprising means for producing an electric field and arranged to control the ionised vapour of precursor.

27. Apparatus according to claim 22 comprising means for producing a magnetic field and arranged to control the ionised vapour of precursor.

28. Apparatus according to claim 26 comprising means for producing a deposition control potential for controlling the deposition of the ionised vapour on the substrate.

29. Apparatus according to claim 28 comprising means for applying a deposition control potential to the substrate onto which the chemical is to be deposited, to control the deposition of the ionised vapour on the substrate.

30. Apparatus according to claim 26 wherein a flow control electrode is provided in a vapour flow path between the forming means and the substrate and means are provided for applying a flow control potential to the electrode to control the flow of the ionised vapour from the forming means to the substrate.

31. Apparatus according to claim 22 comprising means for forming the ionised vapour into a beam and for directing the beam onto the substrate.

32. Apparatus according to claim 22 further comprising means for selecting, by mass spectrometry, ionised precursor to be deposited on the substrate, and for directing the selected ionised precursor to the substrate.

33. Apparatus for performing chemical vapour deposition comprising:

a plurality of sources, each of which is operable to produce an ionised vapour of precursor and includes means for atomising liquid precursor from which said vapour is produced,

a chamber for containing a substrate onto which ionised vapour is to be deposited,

a plurality of vapour paths coupling the respective sources to the chamber,

and, in each path, means for selecting, by mass spectrometry, ionised precursor to be deposited on the substrate, and for directing the selected ionised precursor to the substrate.

34. Apparatus for performing chemical vapour deposition comprising:

a plurality of sources, each of which is operable to produce an ionised vapour of precursor and includes means for atomising liquid precursor from which said vapour is produced,

a chamber for containing a substrate onto which ionised vapour is to be deposited,

a plurality of vapour paths coupling the respective sources to the chamber,

a flow control electrode in each path, and

means connected to each electrode, for applying a flow control potential thereto for controlling the flow of the ionised vapour in its associated path.

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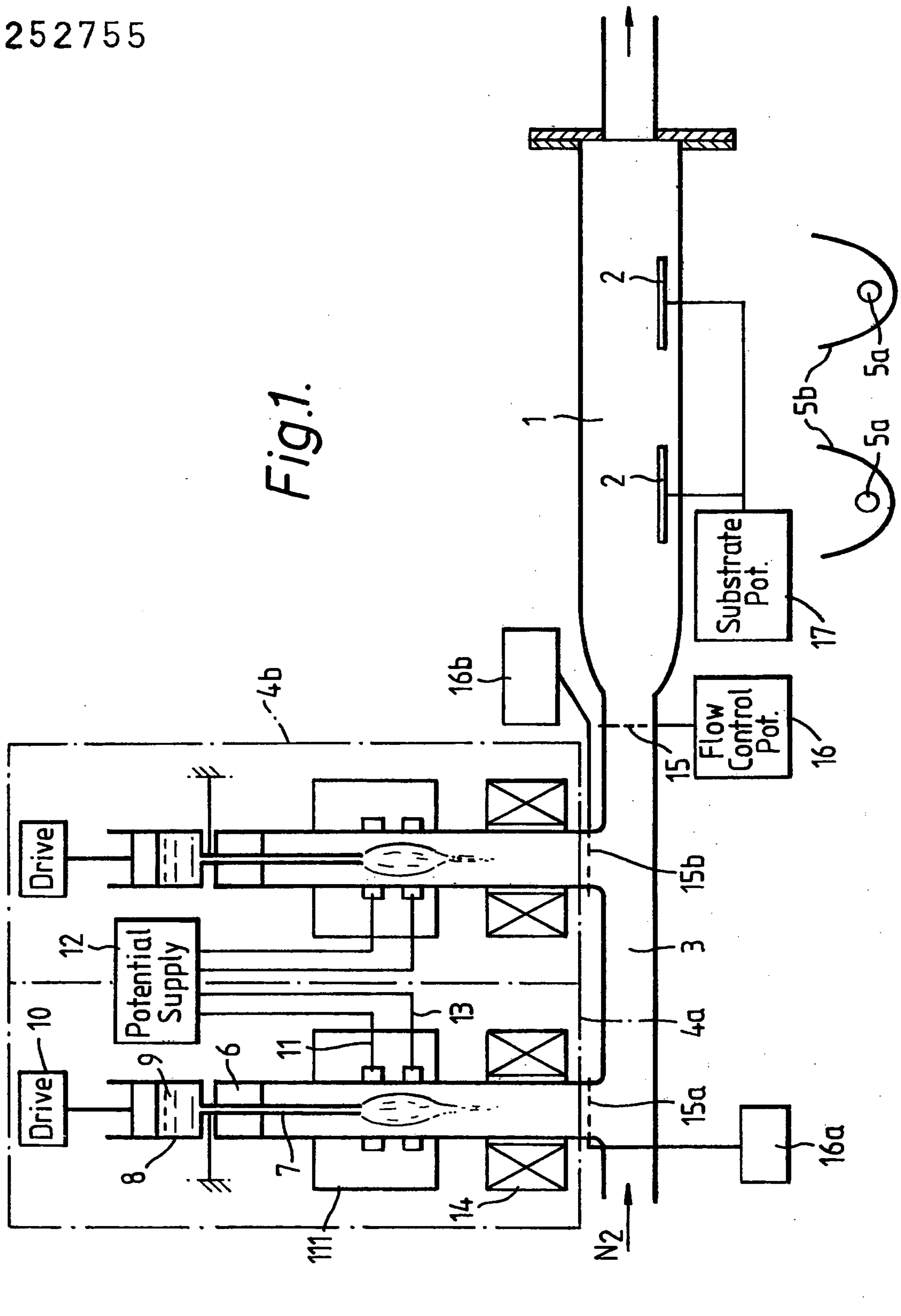
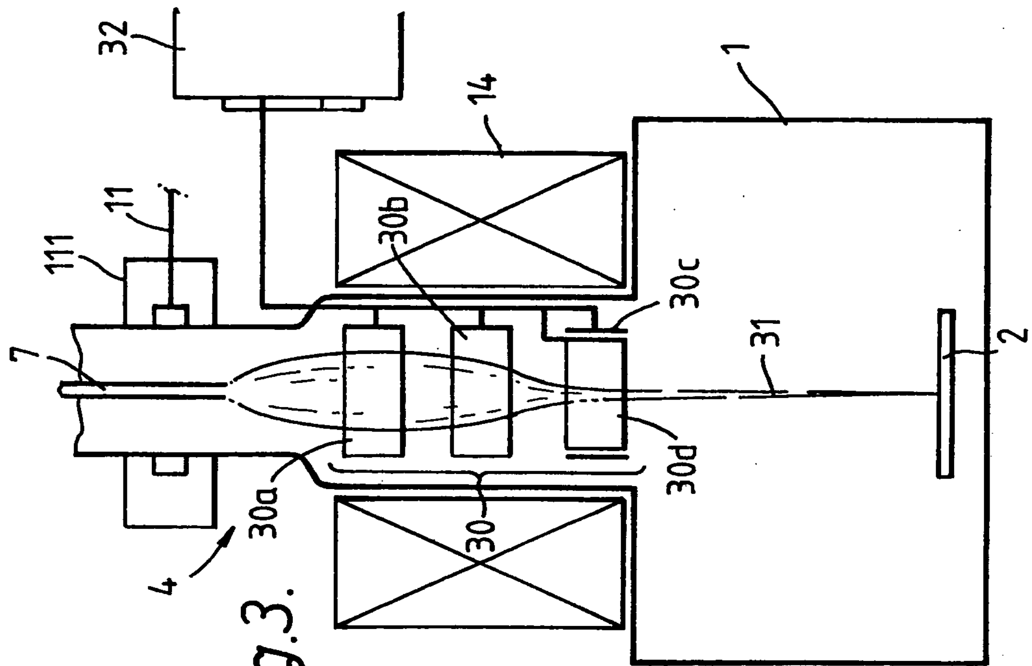


Fig.1.


32
14
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7
30b
30c
31
2
30a
30
30d
4

Fig.3.

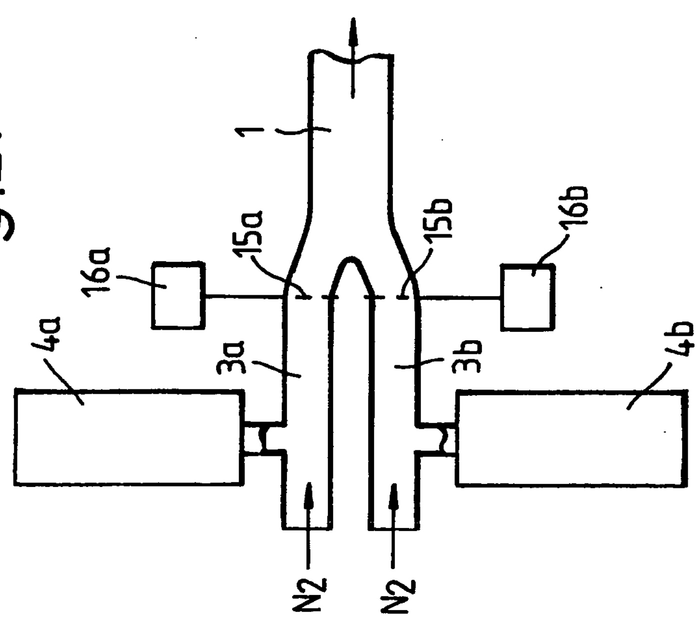
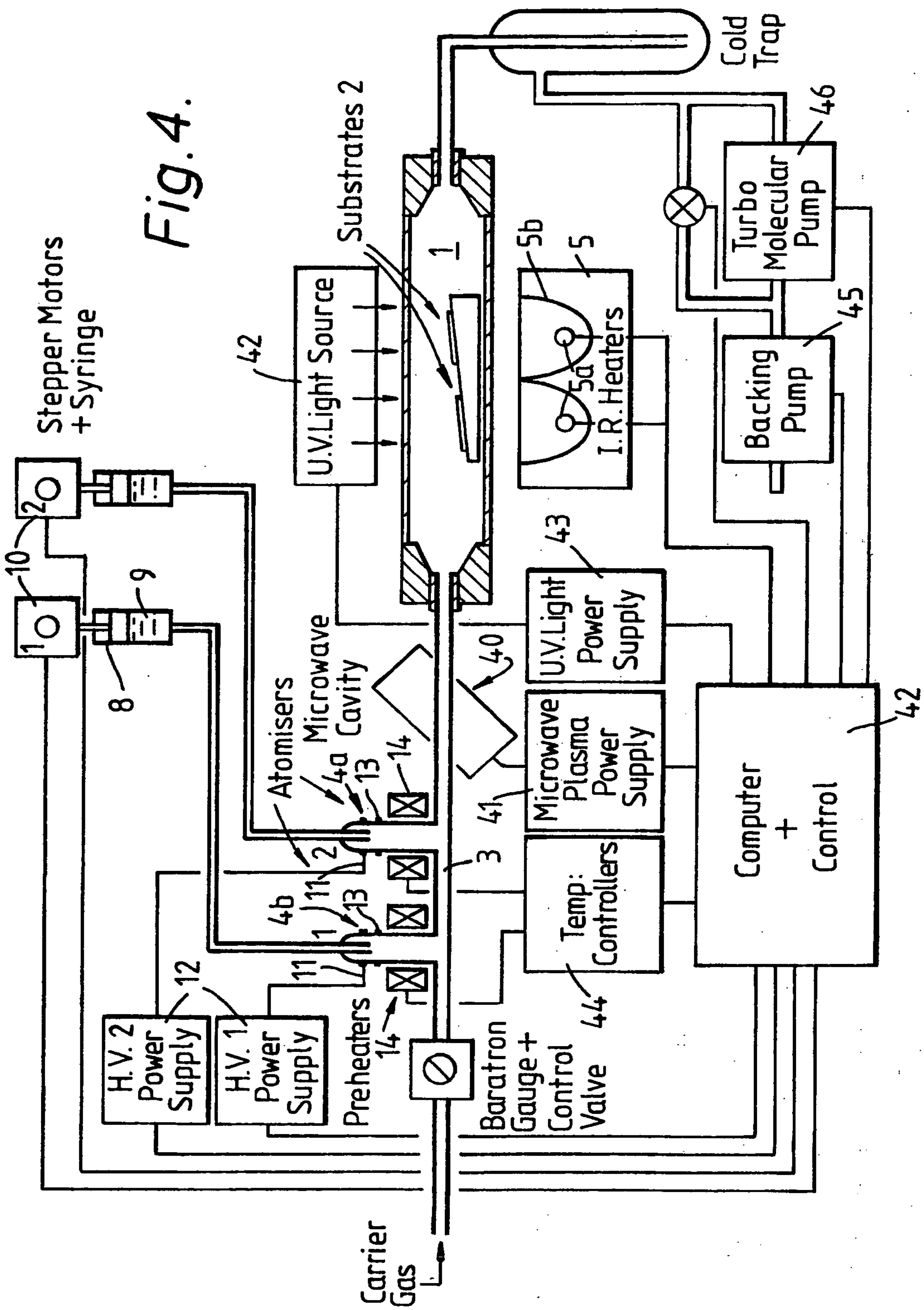
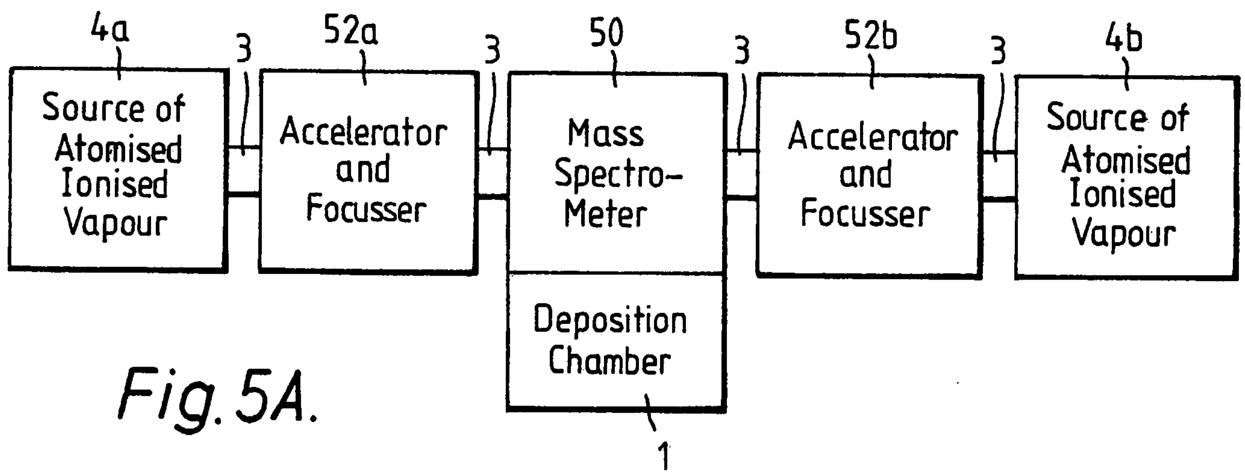

1
16a
15a
15b
16b
4a
3a
3b
4b
N2
N2

Fig.2.



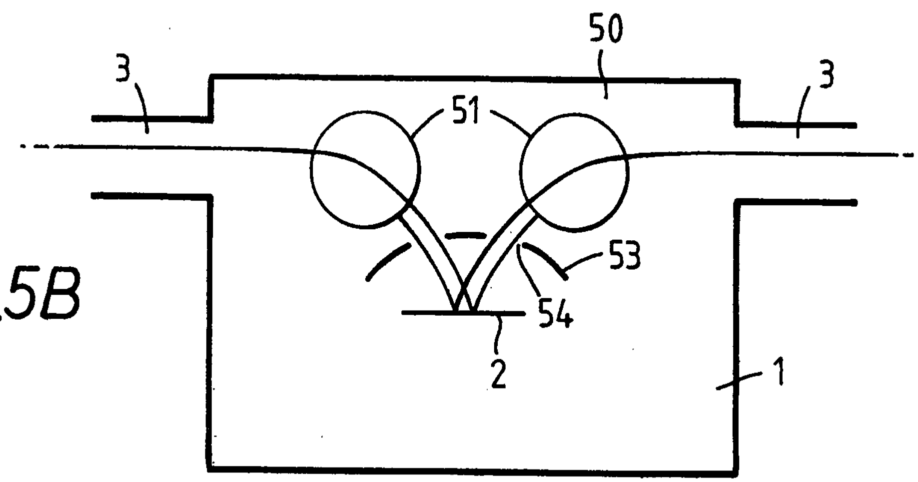
Stepper Motors + Syringe
U.V.Light Source
Substrates 2
Cold Trap
Turbo Molecular Pump
Backing Pump
I.R. Heaters
Microwave Cavity
Atomisers
U.V.Light Power Supply
Microwave Plasma Power Supply
Temp: Controllers
Computer + Control
H.V. 2 Power Supply
H.V. 1 Power Supply
Preheaters
Baratron Gauge + Control Valve
Carrier Gas

Fig. 4.



4a
Source of Atomised Ionised Vapour
3
52a
Accelerator and Focusser
3
50
Mass Spectro-Meter
Deposition Chamber
1
3
52b
Accelerator and Focusser
3
4b
Source of Atomised Ionised Vapour

Fig. 5A.



3
50
51
3
53
54
2
1

Fig.5B

European Patent Office

EUROPEAN SEARCH REPORT

Application number EP 87306126.1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	EP - A2 - 0 183 254 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) * Fig. 1-5; claims *	1,2, 21,22	C 23 C 16/44 C 23 C 16/50 /H 05 K 3/00
A	US - A - 4 582 720 (S.YAMAZAKI) * Abstract; claims *	1,2, 21,22	
A	PATENT ABSTRACTS OF JAPAN, unexamined applications, C field, vol. 9, no. 260, October 17, 1985 THE PATENT OFFICE JAPANESE GOVERNMENT page 56 C 309 * Kokai-no. 60-110 876 (SUMITOMO DENKI KOGYO K.K.) *	1,2	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			C 23 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	18-09-1987	SLAMA

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken al ne
Y : particularly relevant if combined with an ther document of the sam category
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E : earlier patent document, but published on, or after the filing date
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